

# Electrical alternation of T wave without change in QRS complex

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*This paper describes a patient with pericardial involvement of unknown aetiology who showed conspicuous transitory alternans of the T wave without change of the QRS complex. Hypocalcaemia and hypopotassemia were present. The role of this ion imbalance in the genesis of the type of electrical alternans here presented is discussed.*

Electrical alternation of the heart usually involves the QRS complex with or without alternans of the ST segments and the T wave (Kleinfeld, Stein, and Kossmann, 1963). Alternating differences limited to the latter have been observed in animal preparations (Lepeschkin, 1950; Kleinfeld and Gross, 1956; Doherty and Hara, 1961), but are exceptional in clinical electrocardiography (Doherty and Hara, 1961; Littmann, 1963; Kimura and Yoshida, 1963). The following case was, therefore, thought worthy of reporting.

## Case report

A 67-year-old man was admitted to the hospital on 26 September 1968, with a history of loss of weight and abdominal pain of six months' duration.

Physical and laboratory findings included poor general condition, moderate effusion at the base of the left lung, moderately enlarged liver and spleen, high erythrocyte sedimentation rate (135 mm. at the end of the first hour), moderate anaemia (Hb 56%), 3.06 million erythrocytes/cu.mm.), and positive reaction for blood in the stool. Electrocardiogram showed the QT interval at upper limits, but was otherwise normal (Fig. 1).

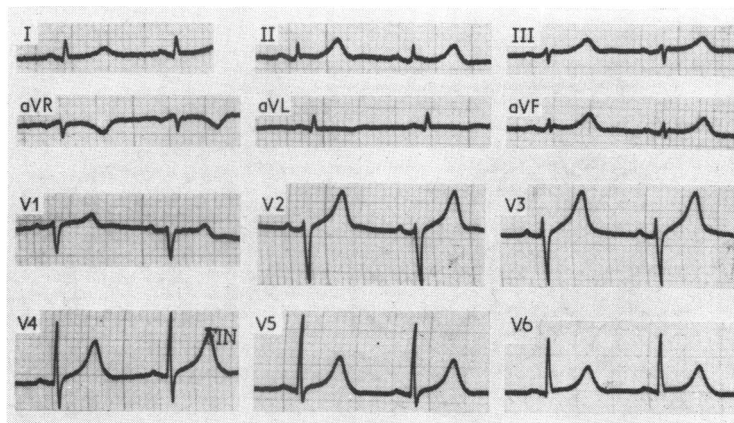
No definite diagnosis was made and the patient's condition remained unchanged till May 1969 when he re-entered the hospital because of an abdominal mass. He was operated on 21 May for a pancreatic pseudocyst. The patient's condition deteriorated after the operation. Bilateral pleural effusion developed, requiring thoracentesis, and from 26 May to 6 June loud

pericardial rubs were heard. The cardiac shadow was within limits at radiological examination. The electrocardiogram revealed obvious widespread inversion of the T waves (Fig. 2). On 3 June electrical alternation limited to the T wave was observed (Fig. 3). It had disappeared two days later. A study of serum electrolytes revealed normal sodium, with a slight hypocalcaemia (8.8 mg./100 ml.) and hypopotassemia (3.2 mEq/l.). The patient developed renal failure and died on 27 June. Permission for necropsy was not forthcoming.

## Discussion

Littmann (1963) was apparently the first to note slight, but definite T wave alternation,

FIG. 1 Electrocardiogram recorded on 26 September 1968. Heart rate is 77 a minute. QT interval is 0.38 sec. (paper speed in all records is 40 mm. per second; each vertical line is 0.05 sec. apart and 1 cm. corresponds to 1 mV).



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without changes in the QRS complex, in a man of 32 with prostatitis, but without demonstrable heart disease. Kimura and Yoshida (1963), the same year, reported the case of a 71-year-old woman, who had a history of arterial hypertension and occasional episodes of tachycardia, and had a raised sedimentation rate, obvious impairment of renal function, and slight hypocalcaemia on hospital admission. Widespread, sharp inversion of the T wave, with obvious intermittent alternation of its depth was noted a few days after cardiovascular collapse occurred while in hospital.

There is some similarity between Kimura and Yoshida's case and the one reported here in which deep inversion of the T wave, transient alternation of this segment of the electrocardiogram without apparent change of the QRS complex, hypocalcaemia, and hypopotassaemia were found. Moreover, there was in our patient evidence of pericardial involvement, though the aetiology of primary disease remained unknown. Both cases suggest that calcium and potassium imbalance may have some bearing on the genesis of alternans limited to the T wave. There is some evidence which seems to support this view. Kleinfeld and Gross (1956) obtained prolonged QT and electrical alternans of the T wave in rabbits during induced hypocalcaemia by ethylene-

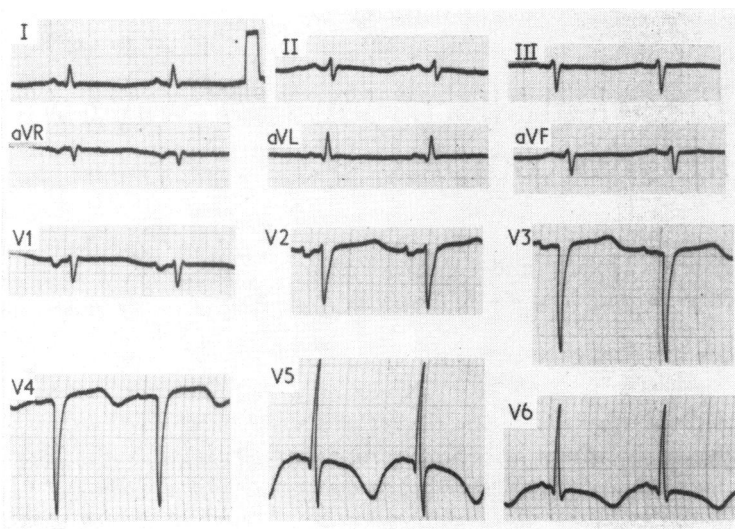
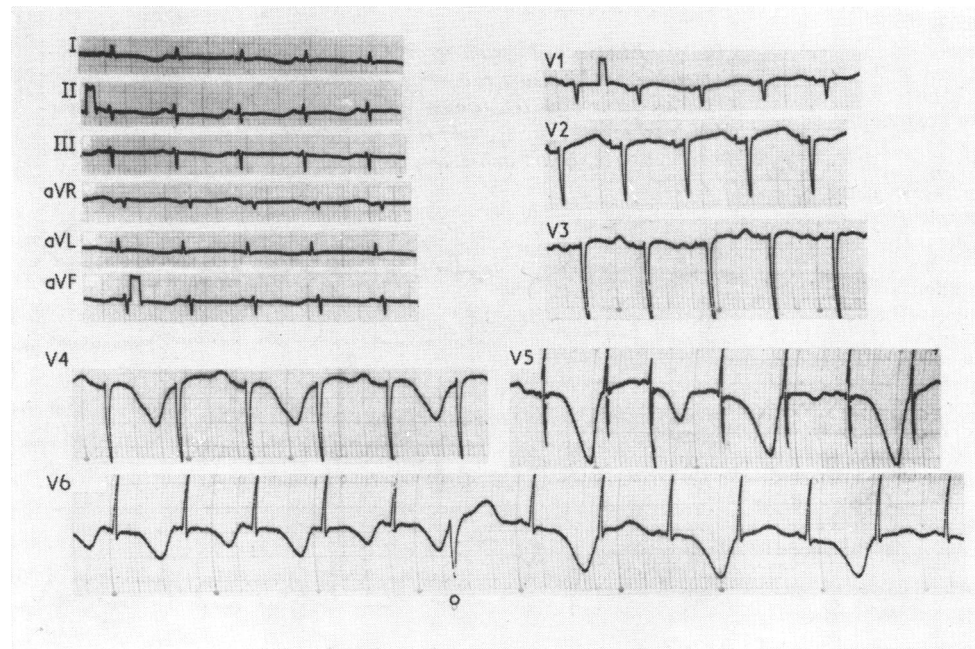


FIG. 2 *Electrocardiogram of 26 May 1969. Inversion of the T waves is best seen in the left precordial leads. Note disappearance of the r wave from lead V1 to lead V4.*

diamine tetra-acetic acid. Doherty and Hara (1961) observed the same electrocardiographic findings in dogs in which hypocalcaemia was induced by intravenous injection of buffered acid dextrose solution. Isolated alternans of

FIG. 3 *Electrical alternans of the T wave without apparent change in the QRS complex. Premature ventricular beat enhances alternation in V6.*



the T wave in clinical cases was reported by the same authors and by Hubbard, Neis, and Barmore (1956) during rapid massive infusion of citrated blood. In Hubbard *et al.*'s patient electrocardiographic changes were apparently corrected through administration of calcium.

The exact mechanism which underlies the various forms of electrical alternans, including the one reported here, is still obscure (Kleinfeld *et al.*, 1963). It has been suggested that the electrical alternation is related to the behaviour of individual fibre membranes rather than to an alternating refractoriness of some myocardial cells (Hogancamp *et al.*, 1959). The alternation in the rate of depolarization and of repolarization of the transmembrane action potential of the cardiac cell was found to correlate with the electrical alternans of the QRS complex and T wave, respectively (Kleinfeld, Stein, and Magin, 1956), and alternation of the rate of repolarization was observed without any apparent change in the rate of depolarization (Kleinfeld *et al.*, 1963; Kleinfeld and Stein, 1968). Some workers (Kleinfeld and Stein, 1968) were also able to separate the cardiac action potential of Purkinje and ventricular fibres of dog heart into a fast spike and a slow (plateau) component and noted alternans of both components. Since there is some evidence that the slow component may be related to variations in potassium and calcium conductance of the cellular membrane (Paes de Carvalho, Hoffman, and Langan, 1966; Orkand and Niedergerke, 1964), one might suppose that alternation in the rate and extent of transport of ions of calcium and potassium across the myocardial membrane is re-

sponsible for the isolated alternation of the T wave.

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